LIGHT WEIGHT NOISE ABSORPTION SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of provisional application serial number 60/544,938 filed February 13, 2004.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The invention relates generally to the field of noise absorption assemblies for use in motor vehicles.

2. Description of the Prior Art

[0003] In the increasingly competitive vehicle market, vehicle manufacturers have strived to reduce the amount of noise transmitted into the passenger compartment from both the road and the engine powering the vehicle. The most common method of stopping this noise transmission is through the addition of high mass sound deadeners affixed to both the floor pan, and the fire wall separating the passenger compartment from the engine compartment. The historical problem with this strategy is that these noise dampeners add a significant amount of mass to the vehicle which reduces the average miles per gallon rating of the vehicle.

[0004] The primary method of blocking noise transmission from the engine compartment into the passenger compartment is through the installation of an interior dash mat that is generally positioned between the instrument panel and the firewall of the vehicle. These dash mats have primarily been manufactured from a layer of urethane foam that is laminated to a heavy plastic or rubber barrier. The urethane foam abuts the firewall to absorb vibrational noise from the firewall while the barrier prevents most of the noise transmitted from the engine compartment from reaching the passenger compartment by blocking the transmission of sound.

[0005] This type of interior dash mat has provided adequate noise reduction in the passenger compartment but has presented many drawbacks. First, this dash mat adds a significant amount of mass to the vehicle. Second, a dash mat typically covers the entire firewall and toe pan area of the floor plan. Due to the size and mass of the dash mat, it is very difficult to install in an accurate location within the vehicle and usually requires multiple people for installation. The installation

process has required various types of fastening devices including, weld studs, insertion fasteners, and clips. Occasionally, the dash mat is attached first to the instrument panel prior to installing the instrument panel into the vehicle, which has resulted in problems with installing the instrument panel into the vehicle. In an effort to reduce the mass of these interior dash mats, light weight materials have been undergoing development to create a low mass dash mat, but have not yet obtained wide scale acceptance in the automotive industry.

[0006] One such low mass dash mat that has been tested is formed from dual density cotton. A first layer of cotton having a first areal mass and a second layer of cotton having a second areal mass is laminated to the first layer of cotton using adhesives. Typically, the areal mass of the second layer is approximately 1828 g/m^2. An additional layer, consisting of an airflow film, is also adhered to the cotton layers to provide a barrier for preventing the flow of air through the dual density cotton of the dash mat. Preventing the flow of air through the dual density cotton is required just to approach near the amount of noise reduction achieved by conventional dash mats. An alternative to cotton has been attempted using dual density polyester. In this type of dash mat, a first layer of polyester having a first density and a second layer of polyester having a second density is laminated to the first layer and an airflow film is attached to the polyester layers prevent the flow of air through the dash mat.

[0007] These new types of dash mats have proven to be lighter than conventional dash mats, and it is believed that further mass savings can still be achieved. Additionally, it is believed that the noise reduction achieved by these new types of dash mats can still be improved upon while reducing cost and complexity.

SUMMARY OF THE INVENTION AND ADVANTAGES

[0008] The present invention relates to a noise absorption assembly comprising a first layer and a second layer. The first layer includes a mixture of first fibers having a first melting temperature and second fibers having a second melting temperature greater than the first melting temperature with the first fibers interwoven with the second fibers. The first fibers are fused to the second layer for holding the first layer to the second layer while maintaining the second fibers free of the second layer.

[0009] The subject invention also provides a method of making a noise absorption assembly having a first layer and a second layer. The first layer includes a mixture of first fibers with a first melting temperature and second fibers with a second melting temperature greater than the first melting temperature. The method includes the steps of overlaying the first layer onto the second layer to form a sub-assembly and melting the first fibers of the first layer by raising the temperature of the sub-assembly to a bonding temperature between the first and the second temperatures to fuse the first fibers to the second layer without melting the second fibers.

[0010] Accordingly, it would be advantageous to have a noise absorption assembly which is light weight to provide a mass savings while providing significant noise reduction. Additionally, it would be advantageous to have a noise absorption assembly that is easier to manufacture while being light weight to improve the installation of the assembly into the vehicle. To solve these problems, the noise absorption assembly is constructed using light weight polymeric materials to form the layers of the assembly while having good noise absorption and airflow resistivity properties to reduce the transmission of noise.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Other advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0012] Figure 1 is a perspective view of a noise absorption assembly for a vehicle;

[0013] Figure 2 is a partial cross-sectional side view of the noise absorption assembly; and

[0014] Figure 3 shows a scatter-graph of a sound absorption coefficient relative to the frequency of noise as produced by the absorption assembly.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Referring to the Figures, wherein like numerals indicate corresponding parts throughout the several views, a noise absorption assembly is shown generally at **20**. The noise absorption assembly **20** is used in any application

that requires the absorption of noise. One such application is an interior dash mat **22** for reducing the level of noise transmitted into a passenger compartment of a vehicle from either the road or the engine through a floor pan (not shown) or firewall (not shown).

[0016] The noise absorption assembly **20** includes a first layer **24** and a second layer **26**. The first layer **24** provides stiffness and noise absorption properties for the assembly **20**. Stiffness of the assembly **20** is desired for maintaining the assembly **20** in a desired three-dimensional shape. The first layer **24** includes a mixture of first fibers **25** having a first melting temperature and second fibers **27** having a second melting temperature greater than the first melting temperature. The first fibers **25** are interwoven with the second fibers **27**. Preferably, the fibers **25, 27** are polyester with the second fibers **27** being more flexible than the first fibers **25**. These fibers **25, 27** also act to absorb noise through the assembly **20**. The second layer **26** provides a barrier providing air resistivity for preventing the transmission of noise through the assembly **20**.

[0017] The first layer **24** has an areal mass in the range of 430 g/m^2 to 1290 g/m^2 and an initial thickness in the range of 20 mm to 35 mm. A first layer **24** having an areal mass of 484 g/m^2 is represented in Figure 3. The second layer **26**, which is formed from a non-woven mixture of polyester and rayon, has an areal mass in the preferred range of generally 90 g/m^2 to 110 g/m^2 and a thickness in the range of 0.5 mm to 2.0 mm. Additionally, the second layer **26** is generally imperforate and has an airflow resistivity in the range of 700 Rn/m^3 to 800 Rn/m^3, which is known to reduce sound transmission. A second layer **26** having an areal mass of 100 g/m^2 is represented in Figure 3. The low areal mass of the second layer **26**, combined with the high airflow resistivity, functions to limit airflow through the assembly **20**. Limiting airflow through the assembly **20** reduces the amount of noise that is transmitted.

[0018] The noise absorption assembly **20** is constructed by overlaying the first layer **24** onto the second layer **26** to form a sub-assembly. If an assembly **20** requires additional bonding strength between the layers, an adhesive is applied in addition to fusing the first fibers **25** to the second layer **26** between the first and the second layers **24, 26**. However, this is not required. The sub-assembly is then inserted into a press. The temperature of the press is heated to a bonding temperature

between the first and the second melting temperatures of the fibers. The bonding temperature is sufficient to melt only the first fibers **25** while not melting the second fibers **27** or any other layer **24, 26** of the sub-assembly.

[0019] After the sub-assembly is inserted into the press, the press is closed. When the press is closed, the press compresses and applies heat, at the bonding temperature, to the layers **24, 26** of the sub-assembly. The press is essentially a three-dimensional mold for shaping the sub-assembly to the contours of the desired location of the vehicle. As the press applies the bonding temperature and compression to the layers **24, 26** of the sub-assembly, the first fibers **25** of the first layer **24** melt and fuse to the second layer **26**. Additionally, because the first fibers **25** are melted and mixed throughout the first layer **24**, the first layer **24** compresses to conform to the three-dimensional shape of the press. For example, the first layer **24** is compressed to form strengthening ribs **28**, for providing additional stiffness to the assembly **20**, or indents **30**, for providing clearance to various vehicle components. By virtue of the fusion between the first and the second layer **24, 26**, the entire assembly **20** takes on the three-dimensional shape of the press. Therefore, the sub-assembly is compressed and permanently deformed into any desired three-dimensional form.

[0020] The first fibers remain fused to the second layer **26** or in the compressed state once they are cured. The first fibers **25** cure when their temperature drops below the first melting temperature and solidify to a state more rigid than the second fibers **27**. After the sub-assembly is compressed and heated to form the desired three-dimensional assembly **20**, the melted first fibers of the first layer **24** are cured. Chilling the sub-assembly to cure the first fibers **25** of the first layer **24** improves the cycle-time of producing the noise absorption assembly **20** by accelerating the time it takes to cool the first fibers **25**. Once the melted first fibers **25** are cured, the first fibers **25** are fused to the second layer **26** of material and permanently maintain the three-dimensional shape of the assembly **20** by virtue of the fusion between the layers **24, 26** and the reformation of the first fibers **25**. Additionally, because the second fibers **27** do not melt under application of the bonding temperature to the sub-assembly, and the second fibers **27** are interwoven with the first fibers **25**, the second fibers **27** are maintained free of the second layer

26. Thus, in addition to providing strength to the assembly **20**, the second layer **26** is capable of absorbing noise.

[0021] Additionally, holes **32** and openings **34** are formed through the assembly **20** to provide clearance for vehicle components. One way that the holes **32** and openings **34** are formed is by using a water jet. However, other methods of forming openings **34** can also be used, such as, for example, piercing in a die press.

[0022] To provide an assembly **20**, with even greater noise absorption properties, a layer of closed-cell polymer foam (not shown) is fused to the first layer **24**, in addition to the first layer **24** being fused to the second layer **26**. The closed-cell foam layer can be adhered to the first layer **24** when the first fibers **25** are fused to the closed-cell foam layer for holding the first layer **24** to the closed-cell foam layer while maintaining the second fibers **27** free of the closed-cell foam layer. A layer of closed-cell foam provides additional benefits by providing an added barrier of air flow resistance.

[0023] To provide additional stiffness to the assembly **20**, a scrim layer (not shown) is optionally adhered to the first and/or the second layer **24, 26**. Preferably, the scrim layer is placed on the appropriate layer **24, 26** of the sub-assembly prior to the sub-assembly being placed in the press. When the scrim layer is adhered to the first layer **24**, the first fibers **25** are fused to the scrim layer for holding the first layer **24** to the scrim layer while maintaining the second fibers **27** free of the scrim layer. However, adhesive may also be used to fuse the scrim layer to the assembly **20**. In addition to providing additional thickness, the scrim layer is used as a protective sheet for the first or the second layer **24, 26**.

[0024] Due to the assembly **20** being light weight, fasteners are not required for attachment of the assembly **20** into the vehicle. Preferably, the assembly **20** is attached to the vehicle using an adhesive, such as a double-sided tape **38** or glue. Additionally, the assembly **20** is installed into the vehicle by a single person.

[0025] While the invention has been described with reference to an exemplary embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the

invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.